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OBSERVATIONS OF SATURN'S RINGS IN 1907.[1]

Since July 23, 1907, the planet *Saturn* has been kept under observation as regularly as the weather, and the arrangement of the programme of work with the 36-inch telescope have permitted. Unfavorable weather conditions made it undesirable to examine the planet earlier in the year, and my observations will now be interrupted by absence from the observatory.

Though, according to the American ephemeris, the Sun did not pass through the plane of the rings until about 16^h, P. S. T., July 24th, the rings were seen as a very bright line[2] on the preceding morning, July 23d, 15^h, P. S. T., and have been visible whenever examined since that date. As seen in projection on the planet on July 23d and 24th, the line was estimated to be about $0''.2$ broad, the estimate being based on comparisons with the micrometer thread (thickness $0''.10$), placed parallel to it.

On October 4th, the date assigned for the passage of the Earth through the plane of the rings, they appeared as an exceedingly faint line of light on either side of the planet, which, under the very poor observing conditions, was difficult to trace. At the steadiest moments, comparison with the micrometer thread showed that its thickness certainly did not exceed $0''.10$, and was probably not more than $0''.07$. From the appearance of the rings at this date and subsequently, I infer that the Sun had already passed through the ring-plane on July 23d, for they were then certainly broader and much brighter than in October.

No very unusual phenomena were detected until Saturday, October 19th. When I entered the dome on that night, Mr. WRIGHT, who had directed the telescope upon *Saturn* for the benefit of the Saturday-night visitors, called my attention to two bright points or knots in the line of the rings, on either side of the planet. My measures, made a little later, showed these points to be nearly symmetrically placed with respect to the planet, the two preceding ones being a little further out than the corresponding points on the following side. They were so sharp that they might easily be mistaken for satellites.

It is certain that they were not visible on October 12th, for the seeing on that night was good, and the ring was examined with special care to note the effect upon it of the presence of

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[1] Abstract from *L. O. Bulletin,* No. 127.

[2] It was bright enough to be readily visible even in the 12-inch telescope.

Mimas and *Enceladus*. These satellites were practically tangent to the ring, the former on the north edge, very near the preceding extremity, the latter on the south, 2″ or 3″ in from the following extremity.

Unfortunately, the weather prevented further measures until October 31st, though on October 24th the knots were distinctly seen in a transitory break in the clouds that hid the planet. The measures on October 31st, and later dates, place the knots farther from the planet than did those made on October 19th. This increase in distance may be real, though no certain motion has been observed since October 31st, unless, perhaps, in the second knot on the preceding side.

On November 1st, a third knot appeared very near the planet's limb, on either side, but, unfortunately, a dense dripping fog covered the mountain before even one complete set of measures could be secured. These knots were invisible on the preceding night, though the ring, both then and on October 19th, was brighter in this part than farther out.

Measures made on eight nights, between October 19th and November 12th, give the following results for the distances of the knots from the nearer limb of the planet:—

Prec. 3.	Prec. 2.	Prec. 1.	Fol. 1.	Fol. 2.	Fol. 3.
8″.38	3″.47	1″.55	1″.39	2″.84	8″.09

I have had several excellent opportunities to compare the appearance of these knots with the inner satellites when near the extremity of the ring or tangent to its edge. From notes made at these times, I should describe them as being nearly as sharp as small satellites, and as presenting quite closely the appearance of *Enceladus* when it is nearly tangent to the ring. In fact, on October 8th, when *Enceladus* reappeared after eclipse, just north of the ring and near the inner knots, it was for a few moments mistaken for a *new knot*. The two inner knots on the following side are considerably brighter than the others, and sensibly brighter than *Enceladus*. Even the faintest of the knots are decidedly brighter than *Mimas*, which I have not been able to follow closer than 4″ from the planet's limb. There has been no marked change in brightness, except in the inner knot on the preceding side. Since November 8th it has appeared equal to No. 2 on the same side, and to the two outer knots (No. 3), while on November 1st and 2d it was decidedly fainter.

The bright line is not of uniform brightness through its whole extent, the portion between knots 1 and 2 (numbered in order of increasing distance from the planet) being always by far the brightest, while the extremity became exceedingly faint 2″ to 3″ beyond knot 3. This relation holds true for both the preceding and the following sides, but the following side, as a whole, appears to be brighter than the preceding, no doubt because of the brightness of knots 1 and 2 on the former side. On the preceding side, the bright line was usually visible right up to the planet's limb, while on the following side it was usually lost at about 0″.5 from the limb. At all times since October 4th the bright line on either side, near the limb, has been as broad as the adjacent extremities of the part in projection on the planet, and the three portions have been segments of the same straight line. The curvature of the projected portion is hardly sensible. It may also be noted that this portion did not, at any time since July 23d, appear *black,* nor as dark as the illuminated micrometer thread placed beside it. A dark gray, that might be called a half-tone, would best describe its appearance.

When the seeing was poor, the ring would often apparently show gaps; but these always disappeared in the steadier moments, and the line could be seen continuously through its whole extent, except the 0″.5 adjoining the following limb of the planet. When one of the satellites, except *Mimas,* was on the edge of the ring, the line on either side of it was generally invisible, but reappeared as the satellite moved. So far as my observations go, therefore, there has been no gap in the line of the ring.

All of the knots appear to be tangent to the south edge of the line, hence it may be inferred that they are due to irregularities on the illuminated surface of the rings. As the rings are known to be revolving very rapidly, and my measures show no appreciable motion, it is also evident that they are due to causes extending entirely around the ring system. But any more definite explanation is very difficult, the more so from the fact that the inner pair fall well inside of the dark ring, the middle pair about at the extremities of the inner diameter of this ring, and the outer pair on the inner bright ring.

The only reference I can find to similar appearances in earlier years is BARNARD'S[1] note on the lumps on the south edge of ring, on the following side, seen on October 29, 1891. He assumed that they were two of the inner satellites. I have looked up the positions of all the known satellites for that date, and find that not one of them was at all near the lumps, so that unquestionably these were of the same nature as the present appearance.

It is almost unnecessary to add that every precaution has been taken to avoid deception in making these observations. The ring has been examined with different eyepieces, with planet occulted, and with occulting bar removed. Under moderately good conditions it was always easily seen, and the knots were very distinct. Especially have I been careful to convince myself that I was not dealing with such an optical phenomenon as is described by BARNARD.[1] The ring, as seen now, is not an effect of contrasts.

R. G. AITKEN.

[NOTE (added February, 1908).—Professor TUCKER continued these observations after November 12th, and has published the measures of two nights in the Bulletin containing my own. On these dates the inner knot on either side was not visible. He also calls attention to observations of similar phenomena[2] by W. C. BOND, at Harvard, in 1848. It may be proper to state here that I did not attempt to look up original articles on *Saturn* of earlier date than 1892, relying upon several standard discussions of *Saturn* and his system for references to earlier observations. No reference to such irregularities in the ring appears in the works which were consulted. Readers who are interested in the subject are referred to BOND'S original paper in *Harvard Observatory Annals,* Volume II, Part I. BOND'S explanation is simple, and may be adequate so far as the two outer knots are concerned, but apparently it fails to account for the innermost ones. Mr. W. H. WRIGHT suggests that these are due to the attenuated meteoric constitution of the crepe ring.—R. G. A.]

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[1] *Monthly Notices, R. A. S.,* 52, 421.

[2] An important difference, as Professor TUCKER points out, is that BOND makes the knots perfectly symmetrical with respect to the planet, while the present series of measures places the following ones closer.